

## A New Hybrid of *Serpocaulon* (Polypodiaceae) from Costa Rica

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ABSTRACT.—A new hybrid *Serpocaulon* × *sessilipinum* A. Rojas & J.M. Chaves is described. The new taxon has characters intermediate between *S. fraxinifolium* (Jacq.) A.R. Sm. and *S. ptilorhizon* (Christ) A.R. Sm., which are related mainly with leaf size, rhizome scales, shape and division of blade, shape and width of pinnae, number of areolae and sori series, and shape and color of spores.

KEY WORDS.—Taxonomy, Ferns, Hybridization, Neotropics

*Serpocaulon* A.R. Sm. is a segregated genus of *Polypodium* L. (Smith et al., 2006), and many of its species were initially described in *Goniophlebium* (Blume) C. Presl, a genus of about 25 species occurring from India, southeast and eastern Asia, the Himalayan region, and Malaysia to Australasia, Melanesia, Samoa, and Micronesia (Röd-Linder, 1990). However, molecular phylogenetic analysis (Schneider et al., 2004) have shown that *Serpocaulon* is nested in a predominantly New World clade, containing the genera *Microgramma* C. Presl, *Campyloneurum* C. Presl, *Pleopeltis* Humb. & Bompl. ex Willd., *Pecluma* M.G. Price and *Polypodium* s.s., as well as the Pantropical grammitid clade (Smith et al., 2006).

*Serpocaulon* is defined as having commonly anastomosing veins, chevron-shaped areoles, 1–10 series of areoles between the costa and pinnae margin, excurrent veinlets in the areoles, as well as a generally long-creeping, branched rhizome, with peltate, clathrate rhizome scales (at least in the central or basal portion). It also has monolete spores with verrucate and occasionally winged ornamentation (Lloyd, 1969; Coelho and Esteves, 2011; Ramírez-Valencia et al., 2013).

*Serpocaulon* is entirely Neotropical, containing about 40–45 species (Smith et al., 2006). Of these, 14 are restricted to the West Indies, Central America and southern Mexico; two are confined to the West Indies, North America, Central America and northern Colombia, and 26–28 occur in South America (Smith et al., 2006), with the diversification centers being the Cordillera Central of Colombia (Sanín, 2006) and the Brazilian Atlantic Forest (Schwartzburd and Smith, 2013).

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Smith et al. (2006) divided the genus into four informal groups: 1) *S. loriceum*, 2) *S. fraxinifolium*, 3) *S. subandinum* and 4) *S. lasiopus*. The new hybrid described here, between *S. fraxinifolium* (group 2) and *S. ptilorhizon* (group 3), provides evidence that the limits between these groups are weak.

***Serpocaulon* × *sessilipinnum*** A. Rojas & J.M. Chaves, *hyb. nov.* TYPE.—COSTA RICA. Puntarenas: Coto Brus, San Vito, Cerro Paraguas, orillas de la laguna Los Gamboa, 8°47'16.3"N, 82°59'20"W, 1447 m, 3 Nov 2012, *J.M. Chaves et al.* 299 (Holotype: CR; Isotypes: HLDG, MO) (Figs. 1B and E, 2B and E).

**Diagnosis:** The new hybrid differs from *S. fraxinifolium* (Jacq.) A.R. Sm. by having rhizome scales that are relatively smaller, moderately dense, with dark brown central portions and narrower pale margins; blades that are 1-pinnate basally to pinnatisect distally and relative narrower; pinnae that are sessile and deltate to deltate-lanceolate; fewer series of areoles and sori, spores that are whitish, ellipsoidal, most well developed and a few collapsed. Similar characters differentiate the new hybrid form *S. ptilorhizon* (Christ) A.R. Sm. Additionally, *S. ptilorhizon* has rhizome scales that are smaller and less dense than the hybrid, and scales have a blackish central portion and a narrower pale margin; blades that are relatively narrower and pinnatisect; pinnae that are lanceolate to narrowly deltate; fewer series of areoles and sori; and spores that are yellow and regularly ellipsoidal.

**Description.**—*Rhizome* long creeping, 2.5–4 mm in diameter, non-pruinose, moderately scaly; *rhizome scales* 1–2 × 0.9–1.5 mm, orbicular to ovate, clathrate, dark brown centrally, with yellowish to light brown margin 0.1–0.3 mm, appressed, marginally entire to irregularly-lobulate, apically obtuse to rounded; *fronds* 44–53.5 cm long, separated by 0.5–8.5 cm; *stipe* 21.6–25.2 × 0.1–0.2 cm, ribbed, stramineous to light brown, glabrous except for trichomes 0.2–0.3 mm, sparse, brown; *blade* 22.5–28.2 × 13.6–21 cm, narrowly deltate, 1-pinnate to pinnatisect distally, basally truncate, apically subconform; *pinnae* 1.9–10.3 × 0.5–1.7 cm, 8–13 pairs, linear-lanceolate, straight to falcate, basal pinnae slightly deflexed, marginally entire; *apical pinnae* 3.8–11 × 0.8–1.3 cm, similar to lateral pinnae, with 1–2 basal lobules; rachis and costae stramineous to light brown, sparsely scaly, scales similar to rhizome scales; *laminar tissue* glabrous; *veins* reticulate, forming 2–3 series of areoles between costa and margin; *sori* round, located in (1–) 2 lines between costa and margin; *sporangia* glabrous; *spores* 47–51 × 28–38 μm, bilateral, ellipsoidal, convex to slightly concave-convex, exospore prominently verrucate, verrucae 3–6.2 μm, translucent, some with yellow patches, others irregular.

**ADDITIONAL SPECIMEN EXAMINED.**—COSTA RICA. Guanacaste: Liberia, Parque Nacional Guanacaste, sector Santa María, sendero que va al volcán Santa María, zona de campamento, 10°48'03"N, 85°19'02"W, 1600–1700 m, 3 Sep. 2012, *A. Rojas et al.* 10249 (CR, MO, USJ).

**Etymology.**—The specific epithet refers to the sessile pinnae.

*Serpocaulon* × *sessilipinnum* has characters that are intermediate between *S. fraxinifolium* (Jacq.) A.R. Sm. and *S. ptilorhizon* (Christ) A.R. Sm. including



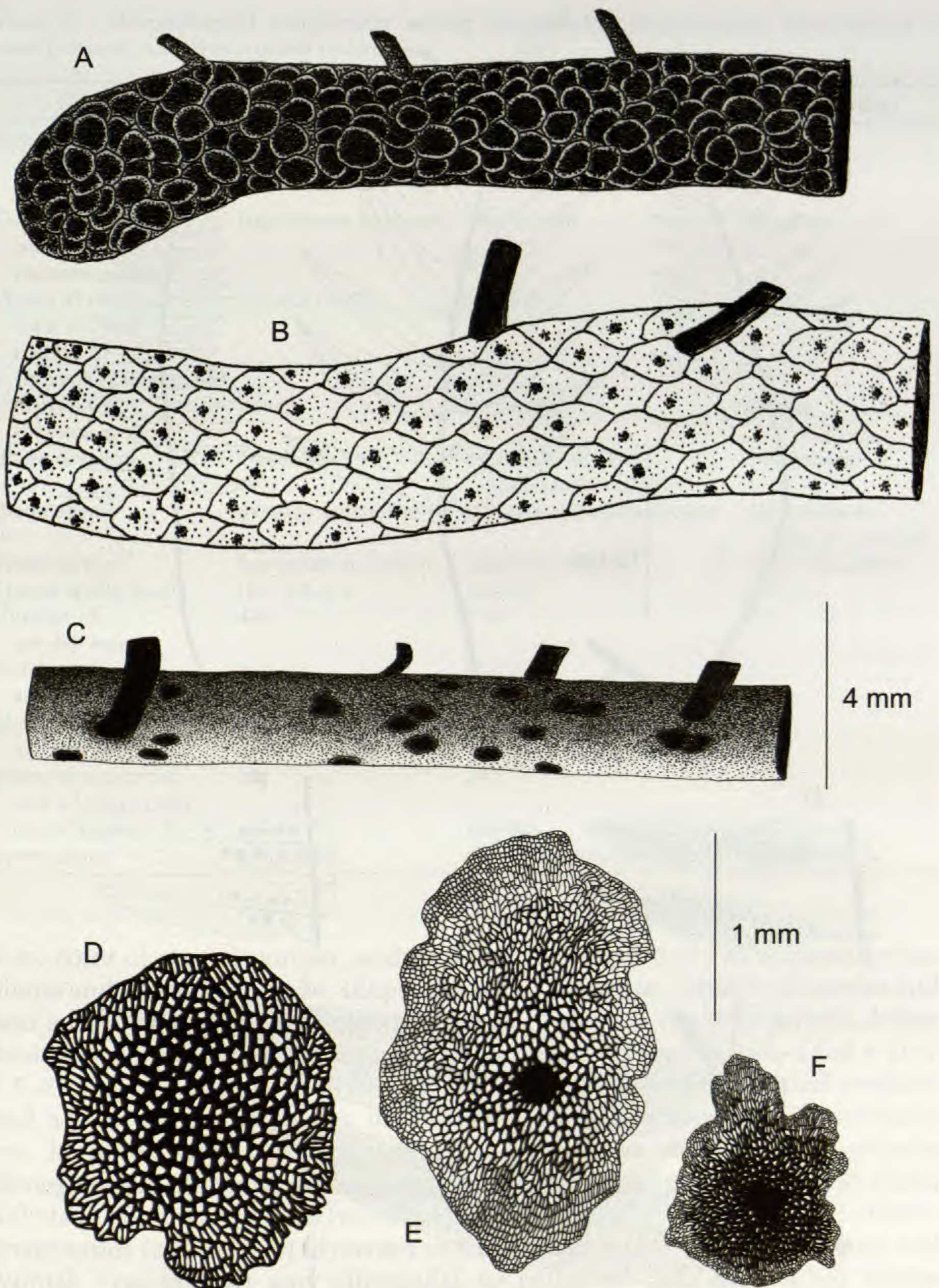


FIG. 1. A and D. *Serpocaulon fraxinifolium* (J.M. Chaves et al. 297, CR); A. Habit. D. Blade detail. B and E. *S. x sessilipinum* (J.M. Chaves et al. 299, CR); B. Habit. E. Blade detail. C and F. *S. ptilorhizon* (J.M. Chaves et al. 298, CR); C. Habit. F. Blade detail.



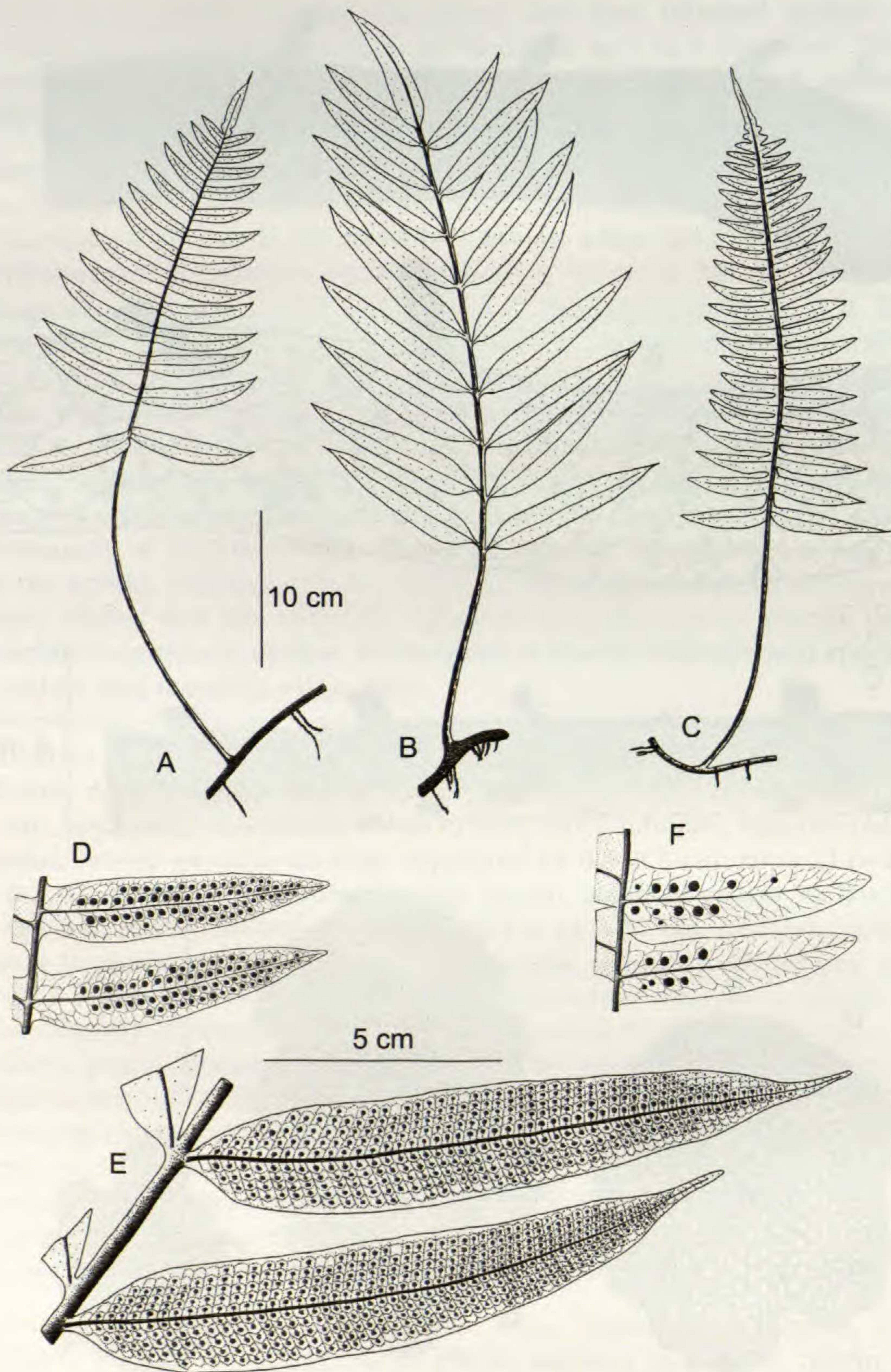


FIG. 2. A and D. *Serpocaulon fraxinifolium* (J.M. Chaves et al. 297, CR); A. Rhizome detail. D. Rhizome scale. B and E. *S. x sessilipinum* (J.M. Chaves et al. 299, CR); B. Rhizome detail. E. Rhizome scale. C and F. *S. ptilorhizon* (J.M. Chaves et al. 298, CR); C. Rhizome detail. F. Rhizome scale.



TABLE 1. Morphological comparison among *Serpocaulon fraxinifolium*, *Serpocaulon* × *sessilipinum*, and *Serpocaulon ptilorhizon*.

Character	<i>S. fraxinifolium</i>	<i>S. × sessilipinum</i>	<i>S. ptilorhizon</i>
Size of rhizome scales (mm)	(1.5-) 2-3 × (1-) 1.5-2	1-2 × 0.9-1.5	0.5-1
Color of central portion of rhizome scales	light brown to brown	dark brown	Blackish
Width of the light colored margin of rhizome scales (mm)	0.2-0.5 (-0.7)	0.1-0.3	≤ 0.1
Density of rhizome scales	dense	moderate	Sparse
Blade division	1-pinnate	1-pinnate basally to pinnatisect distally	Pinnatisect
Blade shape	ovate to lanceolate	deltate to deltate-lanceolate	lanceolate to narrowly deltate
Pinnae shape	lanceolate to elliptic	linear-lanceolate	linear-lanceolate
Pinnae width (cm)	(1-) 1.8-3.3	0.5-1.7	0.5-1.1
Number of areoles series	4-5	2-3	1-2
Number of sori series	3-5	(1-) 2	1
Mean of polar axis of spore (μm)	30.2	48.8	48.4
Mean of equatorial axis of spore (μm)	50	34.5	72.3
Color of spores	yellow	whitish	yellow
Spore shape	ellipsoidal	ellipsoidal or collapsed	ellipsoidal

size, color of central portion, width of pale margin, density of rhizome scales, shape and division of blade, shape and width of pinnae, number of areolae and sori series, and shape and color of spores (Table 1). The new hybrid differs from *S. fraxinifolium* by having smaller (1-2 × 0.9-1.5 mm vs. (1.5-) 2-3 × (1-) 1.5-2 mm) rhizome scales with dark brown (vs. light brown) central portions and narrower (0.1-0.3 mm vs. 0.2-0.5 (-0.7) mm) pale margins with moderate (vs. high) density, 1-pinnate basally to pinnatisect distally (vs. 1-pinnate throughout) blade divisions, relatively narrower (0.5-1.7 cm vs. (1-) 1.8-3.3 cm), deltate to deltate-lanceolate (vs. ovate to lanceolate) and sessile (vs. free) pinnae, fewer series (2-3 vs. 4-5) of areoles and fewer series ((1-) 2 vs. 3-5) of sori, and whitish (vs. yellow) and ellipsoidal to collapsed (vs. ellipsoidal) spores (Table 1).

From *Serpocaulon ptilorhizon*, *S. × sessilipinum* differs by its longer (1-2 × 0.9-1.5 mm vs. 0.5-1 mm in diameter) rhizome scales with dark brown (vs. blackish) central portion and broader (0.1-0.3 mm vs. ≤0.1 mm) pale margin, moderate (vs. sparse) scale density, 1-pinnate basally to pinnatisect distally



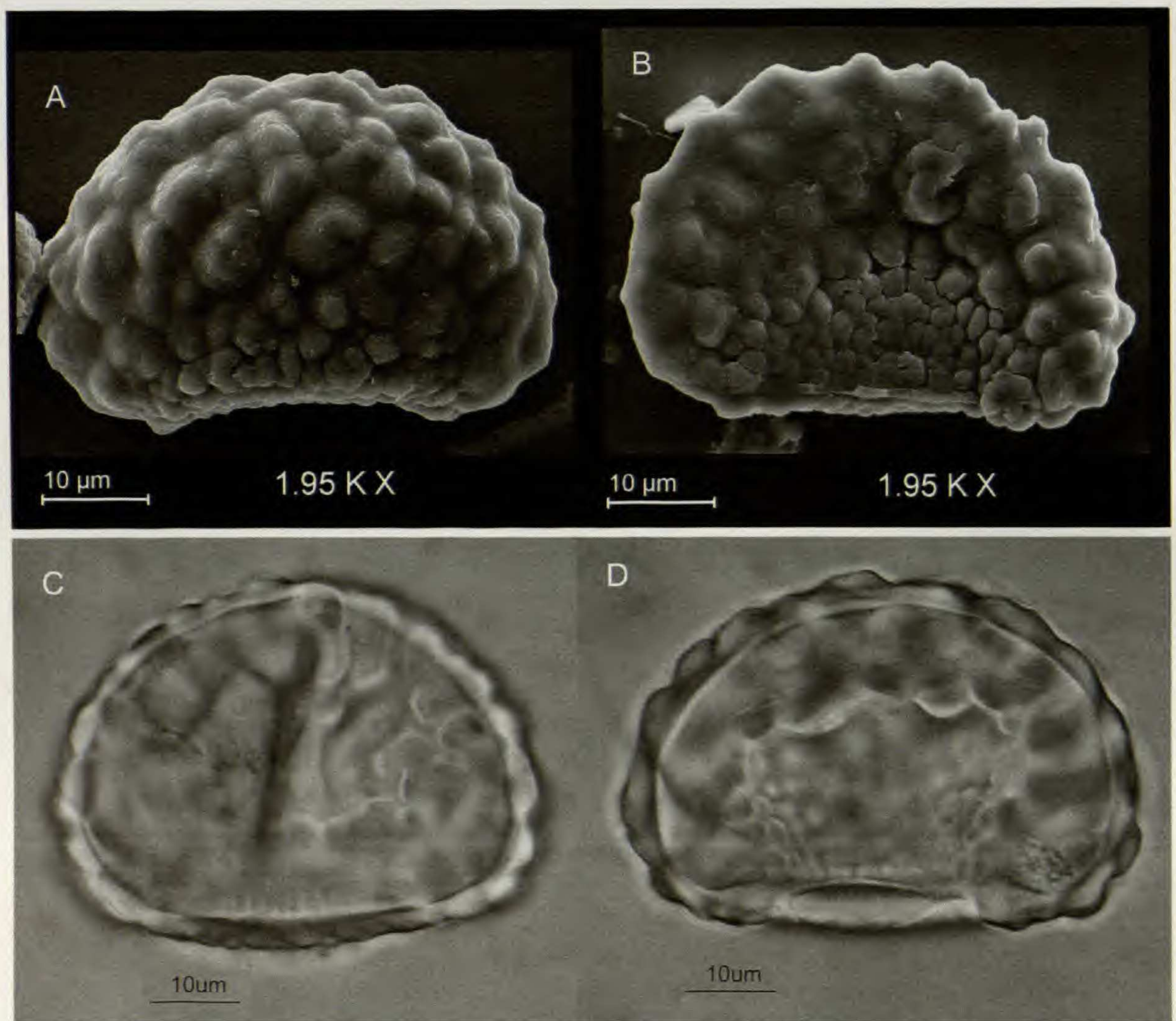


FIG. 3. A–D. *Serpocaulon* × *sessilipinum* (J.M. Chaves et al. 299, CR). A. Well-developed spore in lateral view (Scanning Microscopy). B. Collapsed spore in lateral view (Scanning Microscopy). C. Well-developed spore in front view (Transmission Microscopy). D. Collapsed spore in lateral view (Transmission Microscopy). Photos by Valentina Ramírez-Valencia (April 29, 2013).

(vs. pinnatisect throughout) blade divisions, relatively broader (0.5–1.7 cm vs. 0.5–1.1 cm), deltate to deltate-lanceolate (vs. lanceolate to narrowly deltate) pinnae, relative fewer series (2–3 vs. 1–2) of areoles and fewer series ((1–) 2 vs. 1) of sori, and whitish (vs. yellow) and ellipsoidal to collapsed (vs. ellipsoidal) spores (Fig. 1–2, Table 1).

Besides morphology, the type specimen (J.M. Chaves et al. 299, CR, HLDG, MO) was collected among populations of both *S. fraxinifolium* (J.M. Chaves et al. 297, CR, HLDG, MO) and *S. ptilorhizon* (J.M. Chaves et al. 298, CR, HLDG, MO), what also suggests a hybrid origin involving these two species.

Spore abortion is a key character that provides evidence of hybridization (Moran, 2004), and it has been found in many hybrids in different genera such as *Adiantum* (Moran and Watkins, 2002; Rojas-Alvarado and Herrera-Martínez, 2012), *Asplenium* (Rojas-Alvarado and Chaves-Fallas 2010), and *Polystichum* (Barrington 1985). However, some hybrids can also present



normal spores, as documented by (Ramírez-Valencia et al., 2013, Schwartzburd and Smith, 2013) for *Serpocaulon*. This seems to be the case for the new hybrid here described, which has whitish-translucent spores, but without any content inside (Fig. 3).

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